



# ***Development of Biological Indicators, Methods and Assessment Techniques for Use in Headwater Intermittent Streams***

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## ***Headwater streams as monitoring units***

- 💧 Aquatic-terrestrial interface.
  - Spatially (high channel length : width)
  - Temporally (geologically and seasonally)
- 💧 Widespread, replicate reference conditions generally obtainable.
- 💧 Drain smaller watershed areas, with more homogeneous land use than larger streams (stressor diagnosis).
- 💧 However, headwater streams are more prone to drying...hence a need to identify hydrologic regimes.

## ***Potential stressors / impairments to headwater streams***



- Urban / suburban centers – piping/culverts, impervious surfaces, obliteration
- Appalachians – MTR / VF, longwall mining, straight pipes
- Gulf Coastal Plain – silviculture, ag w/o BMPs
- Midwest – channelization, tiling, livestock, pond impoundments
- West – abstraction/diversion, effluent-dominated flows

## ***Regional Methods Study***

- 💧 Pilot study to develop SOPs for studying intermittent streams.
- 💧 Multi-region study
- 💧 Goals
  - Assess and identify indicators of flow permanence
  - Identify potential stressors to headwater streams



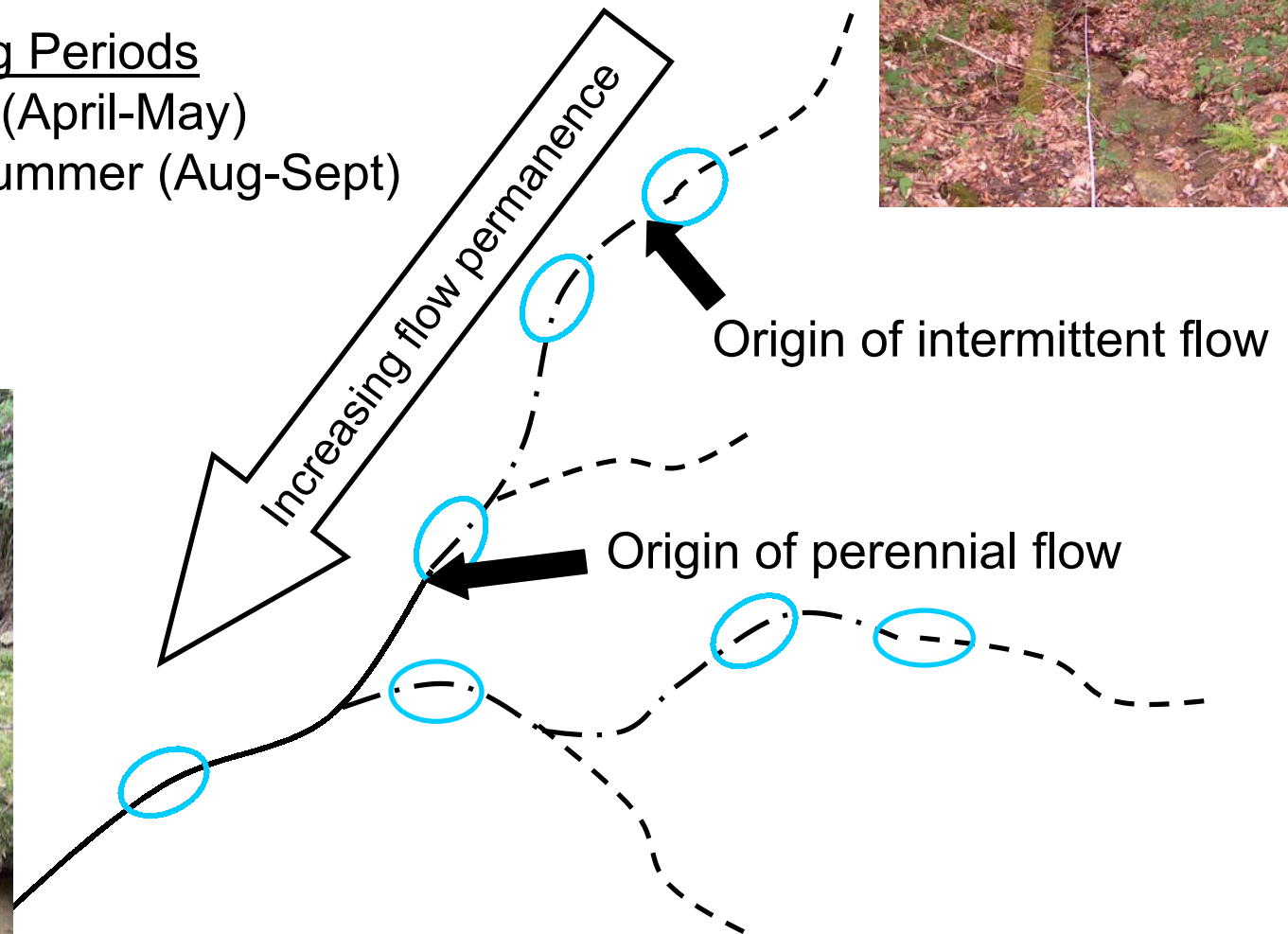
# Study Design

## 3 – 4 reaches per stream

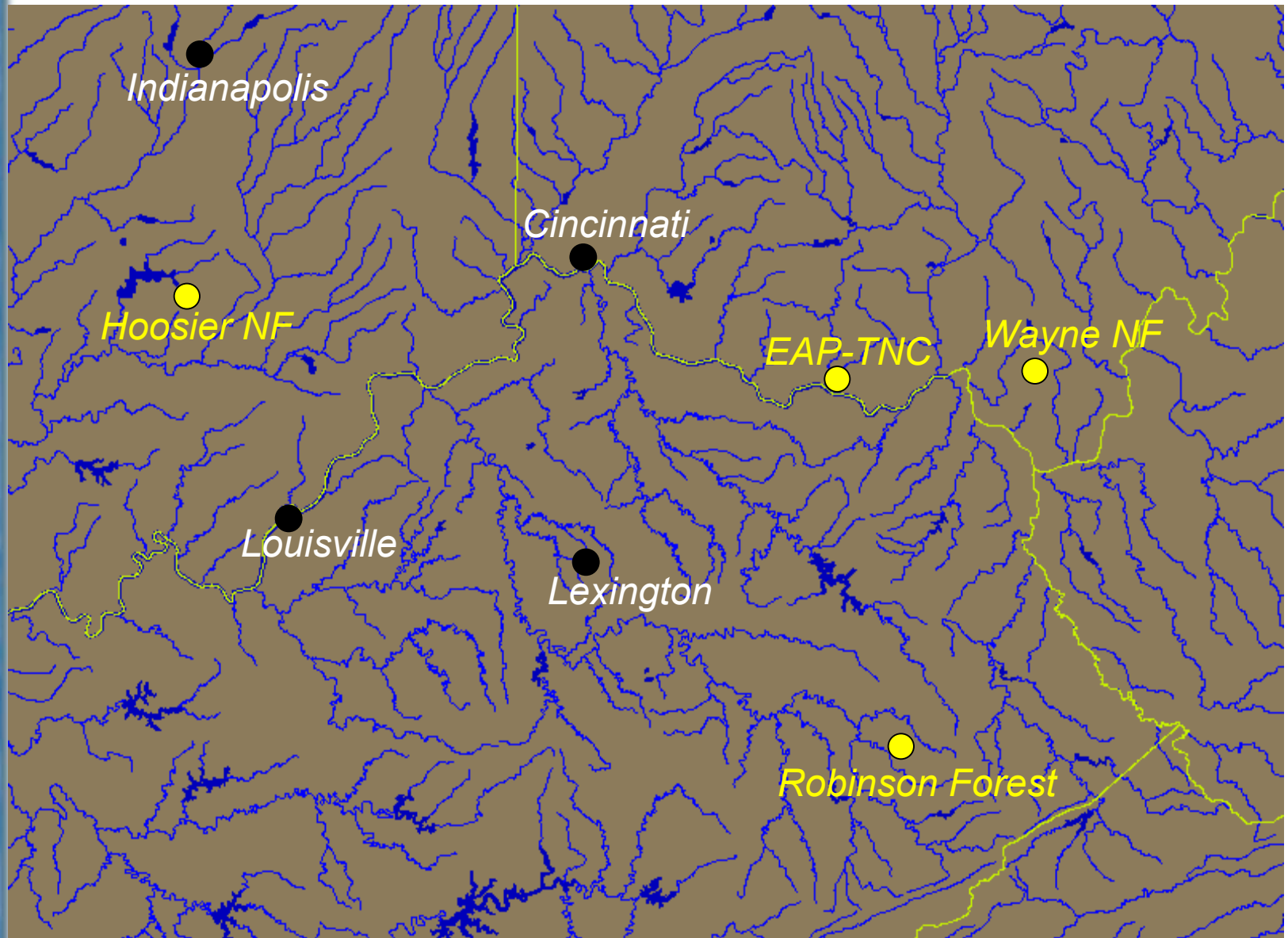
- Gradient of permanence
- 30 m reaches

## Sampling Periods

- Spring (April-May)
- Late Summer (Aug-Sept)

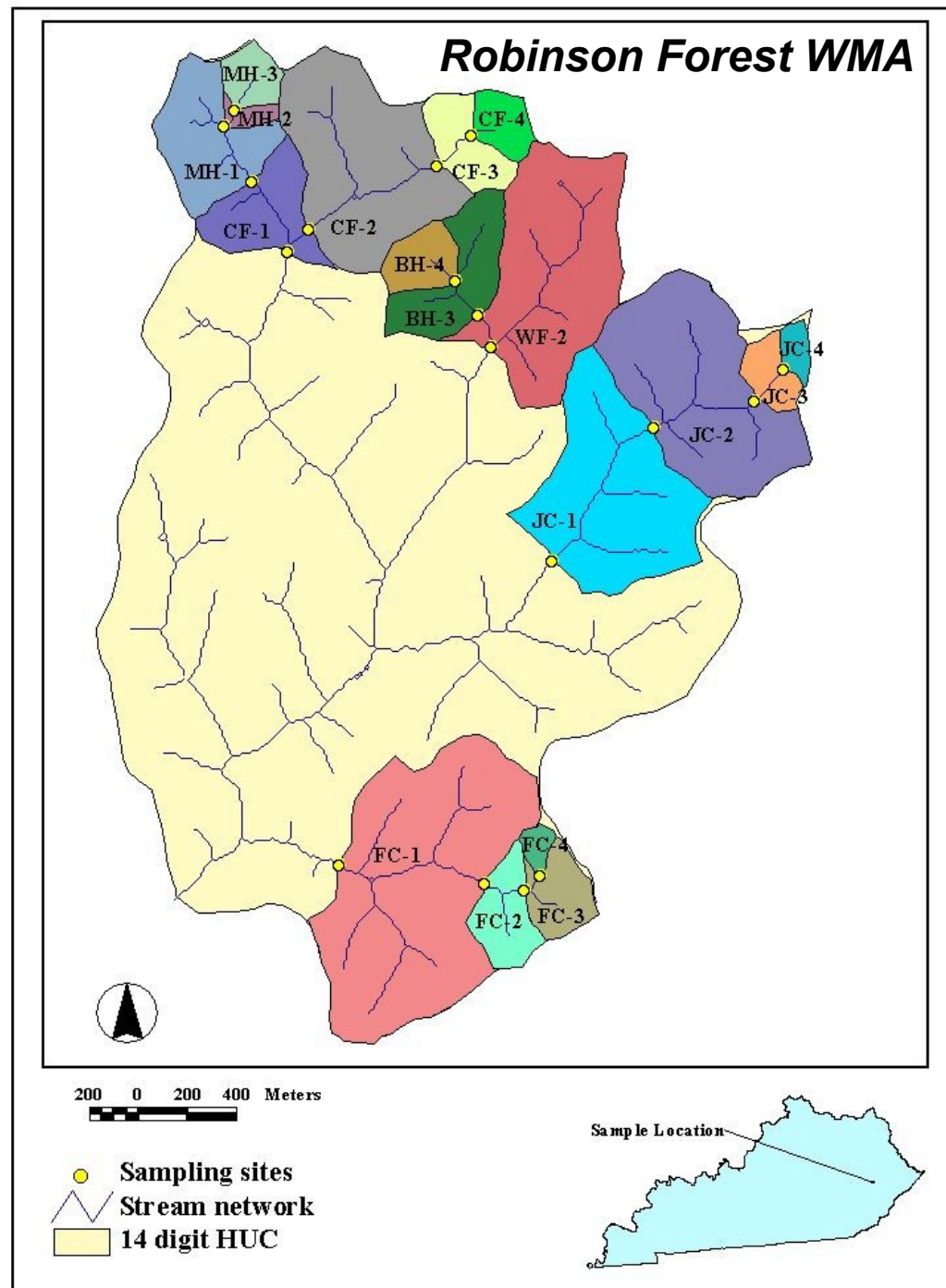


# Year 1 Study Site Locations



**RESEARCH &  
DEVELOPMENT**

*Building a  
scientific  
foundation  
for sound  
environmental  
decisions*





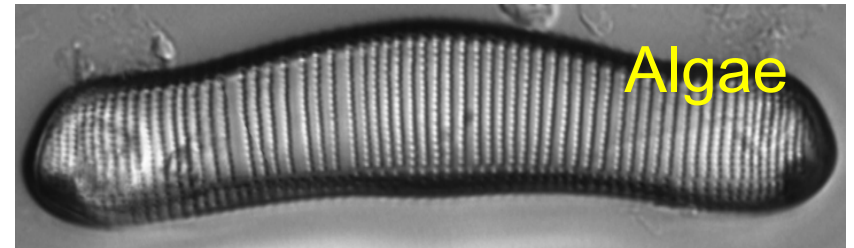
## ***Physical Habitat Variables***

- Quantitative measures within erosional & depositional habitats
- EPA Rapid Habitat Assessment Form
- Ohio EPA Primary Headwater Habitat Evaluation Form (HHEI)
- North Carolina Department of Water Quality Stream Classification Form





# ***Indicator Assemblages***





# ***Biological Sampling***

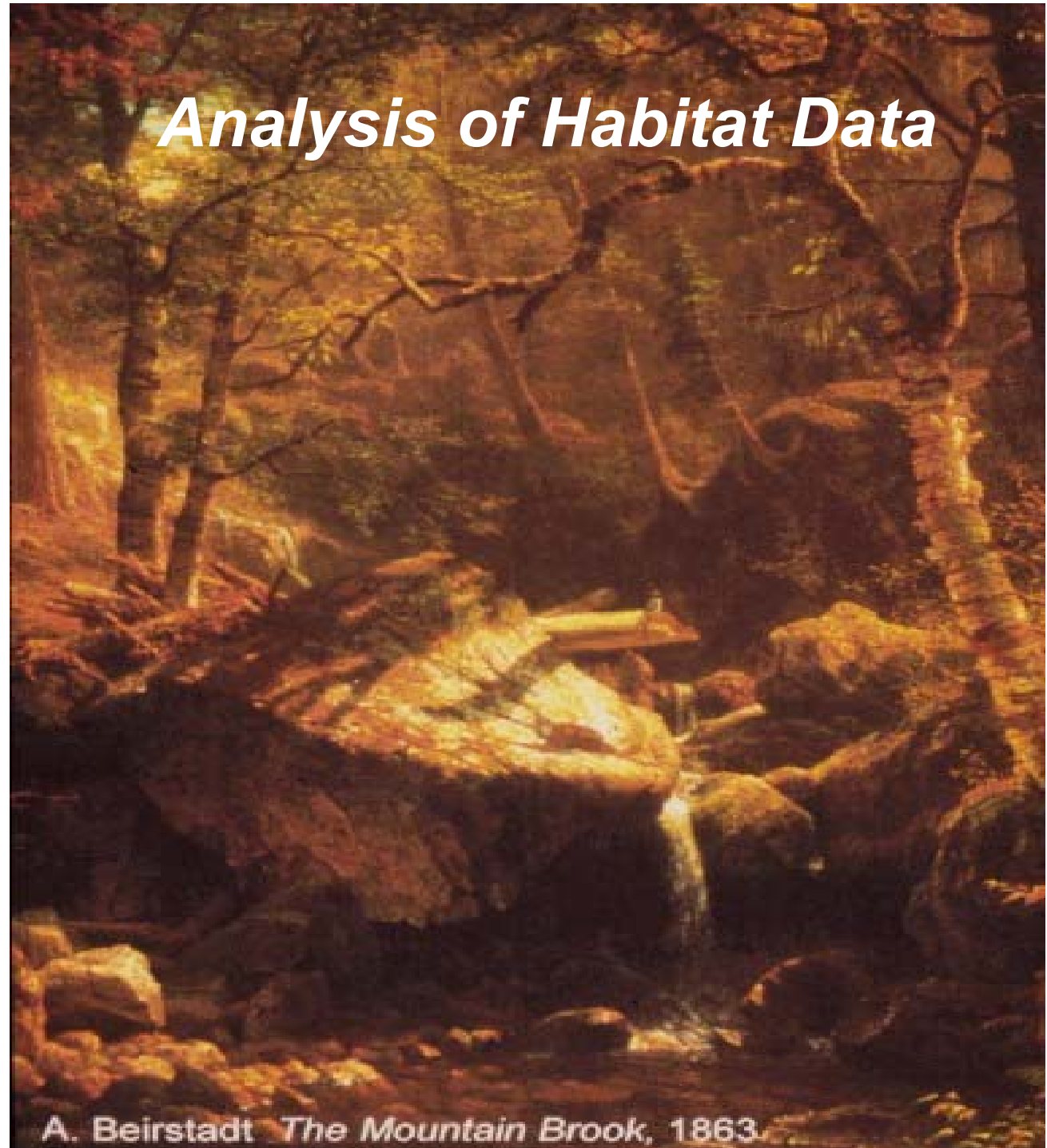
- Macroinvertebrates: 6 stovepipe samples (0.05 m<sup>2</sup>) per habitat type along thalweg
- Algae: Composite 6 samples (12 cm<sup>2</sup>) per habitat type
- Bryophytes: 6 samples per reach
- Amphibians: 30 min visual search upstream of sampling reach



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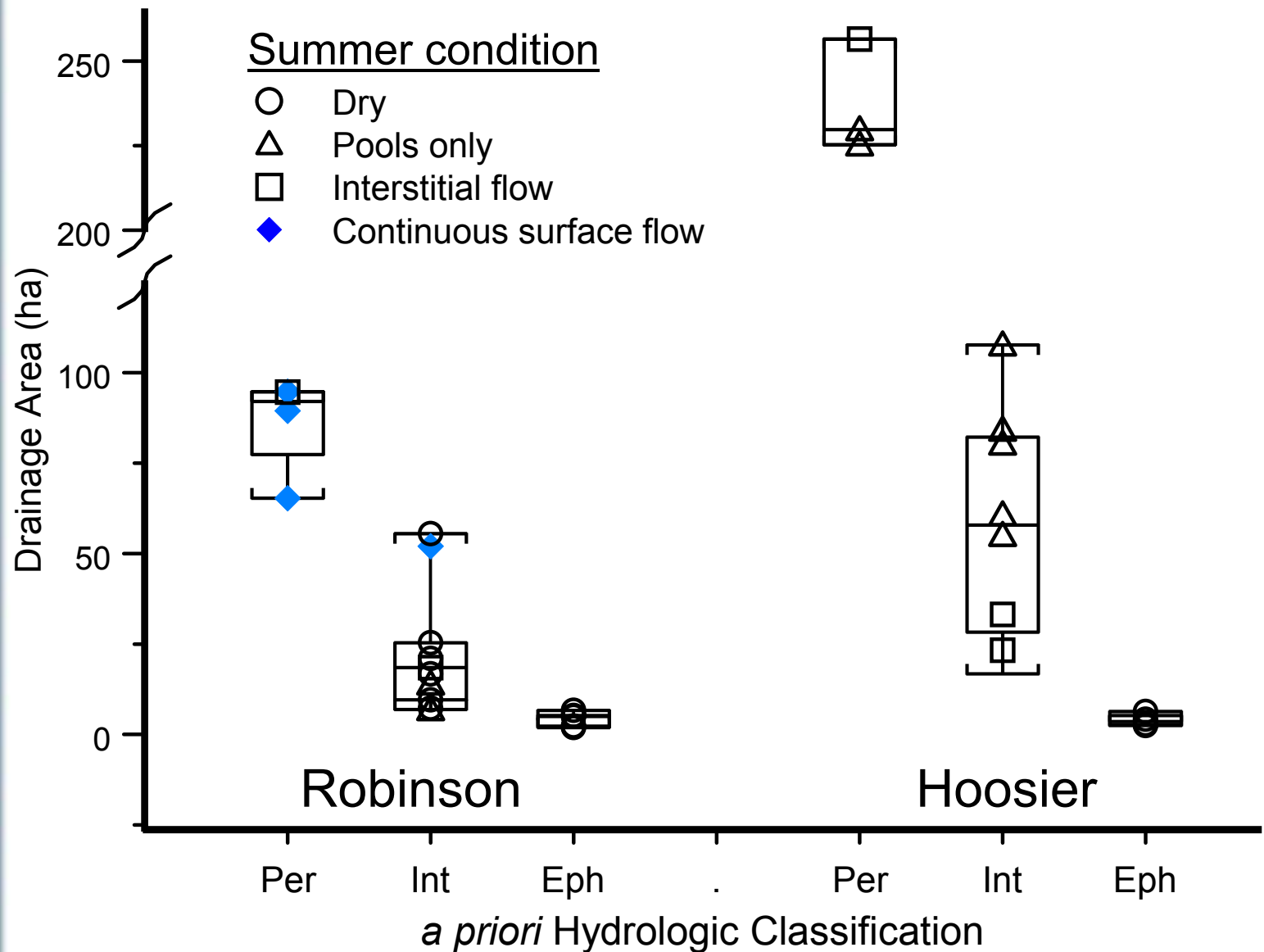
# ***Analysis of Habitat Data***



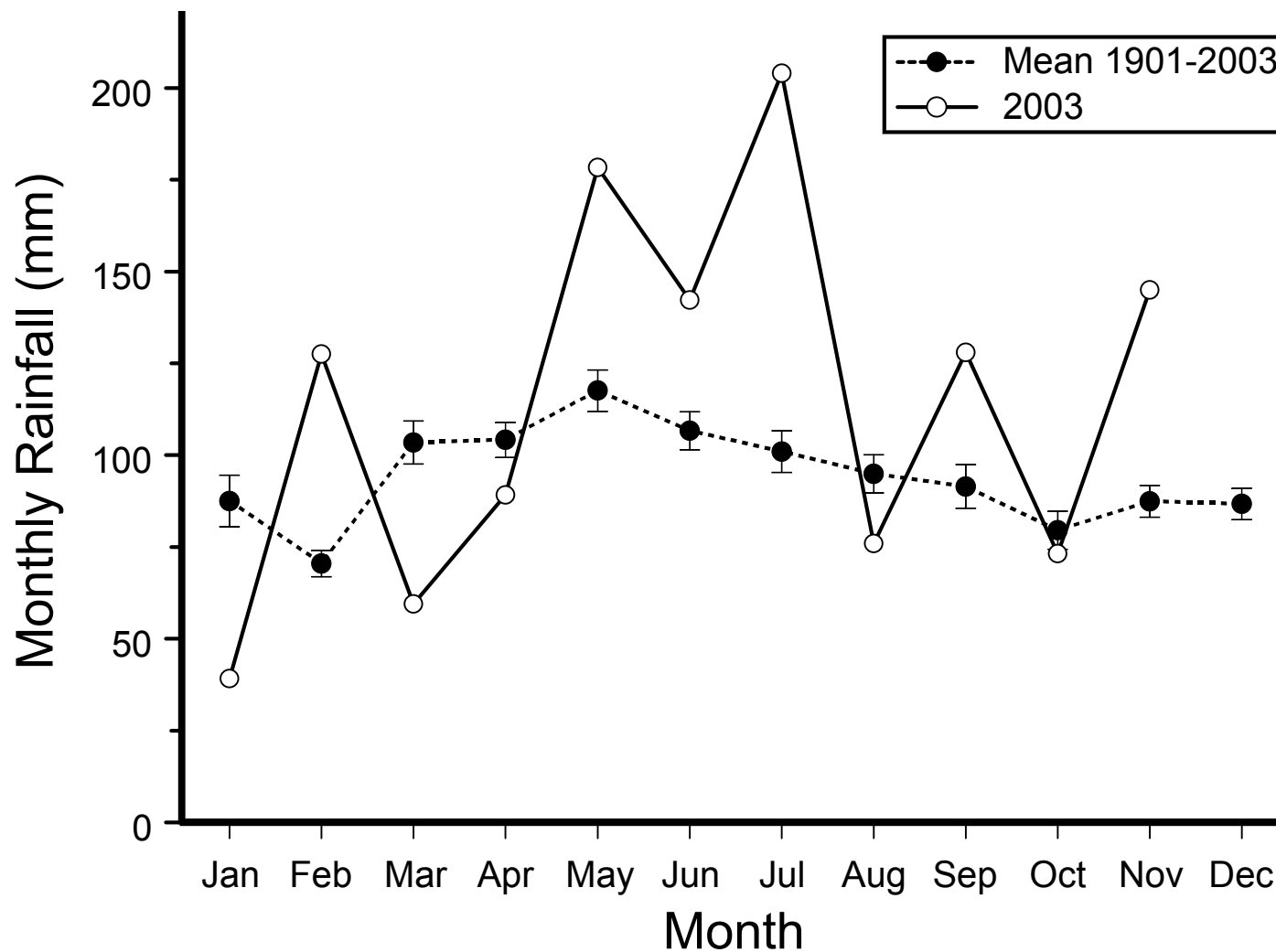
A. Beirstadt *The Mountain Brook*, 1863



# Drainage Area and Hydrology



## ***2003 vs. Long-term Rainfall near Hoosier NF***



# *Hydrologic Classification*

## Spring & Summer Hydrologic Conditions

- 💧 Continuous surface flow } *A*
- 💧 Interstitial flow } *A*
- 💧 Pools only no visible flow – *B*
- 💧 Dry – *C*

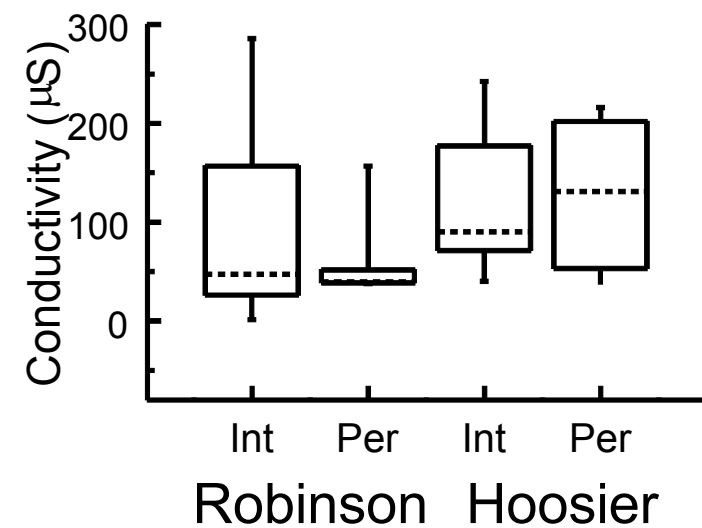
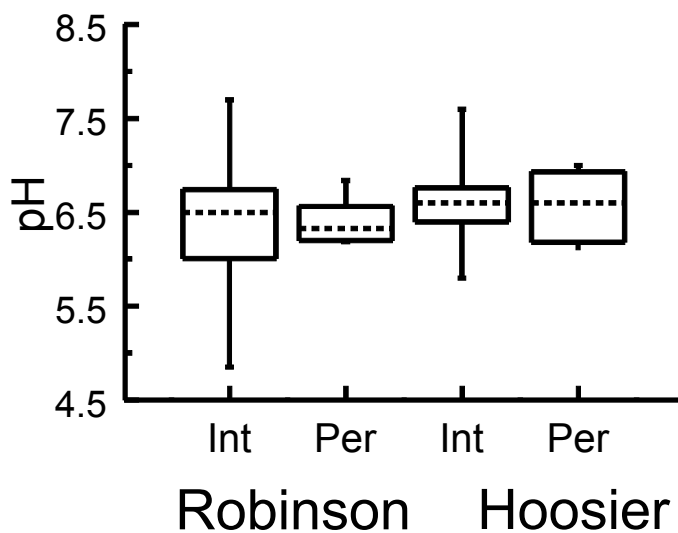
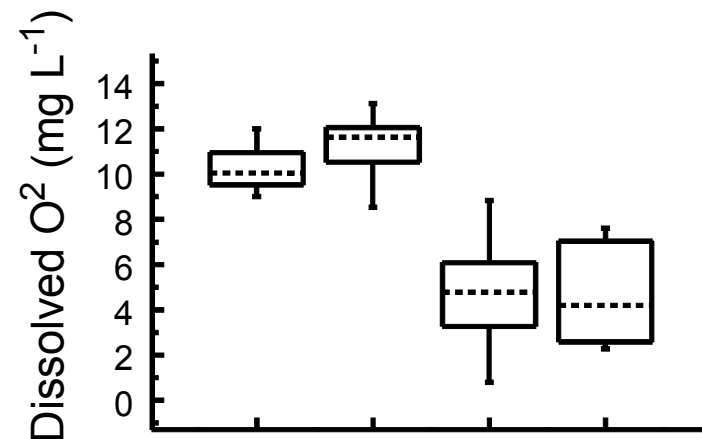
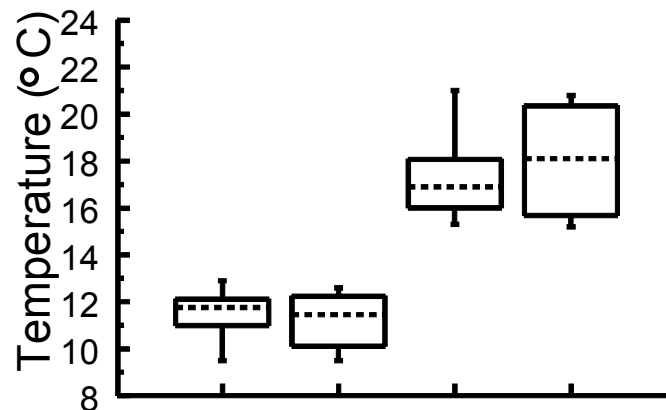
If Spring and Summer = *A* then “perennial”

If Spring = *A* and summer = *B* or *C* then  
“intermittent”

If Spring = *B* or *C* and summer = *C* then  
“ephemeral”

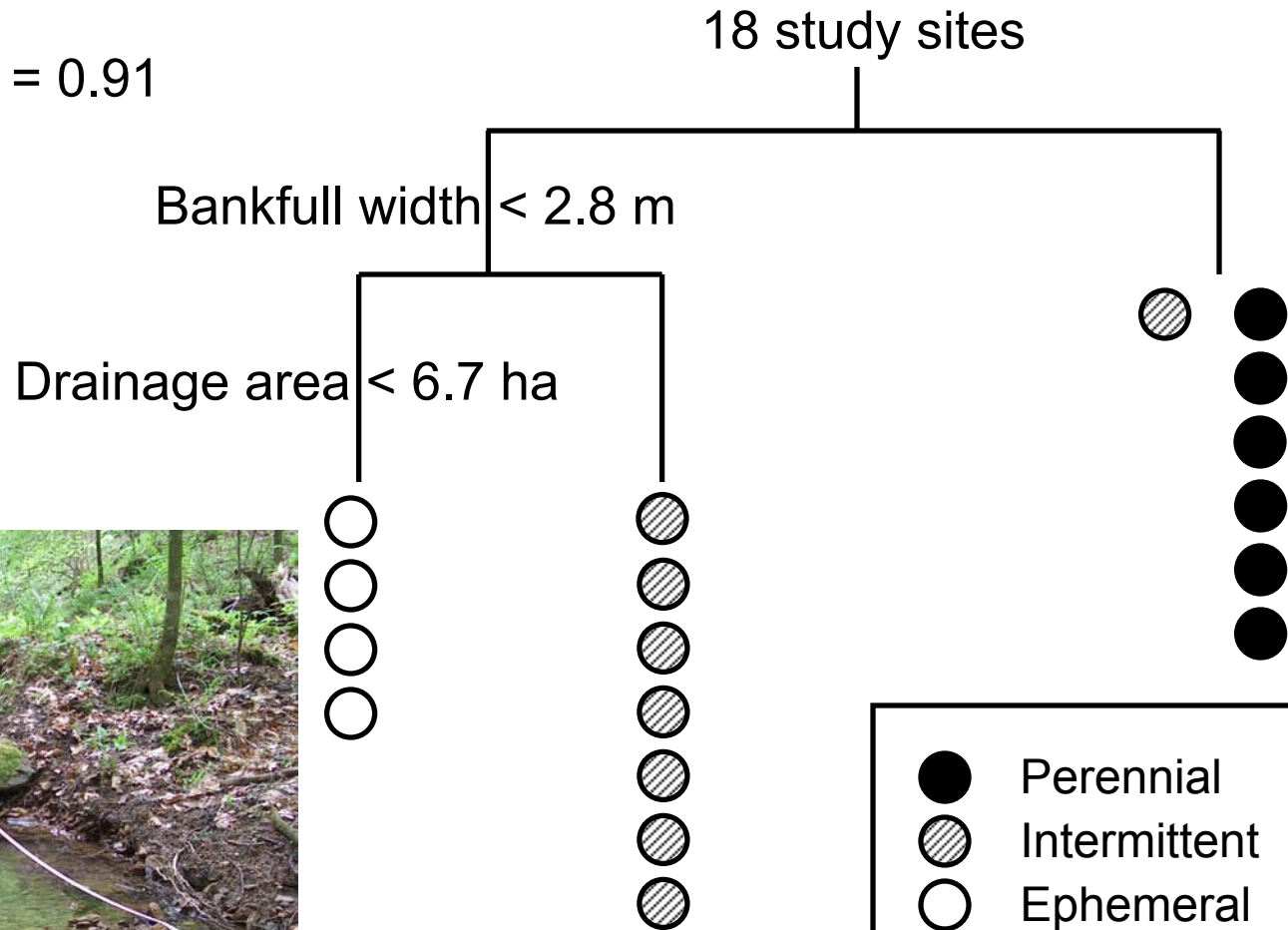


# Water Chemistry



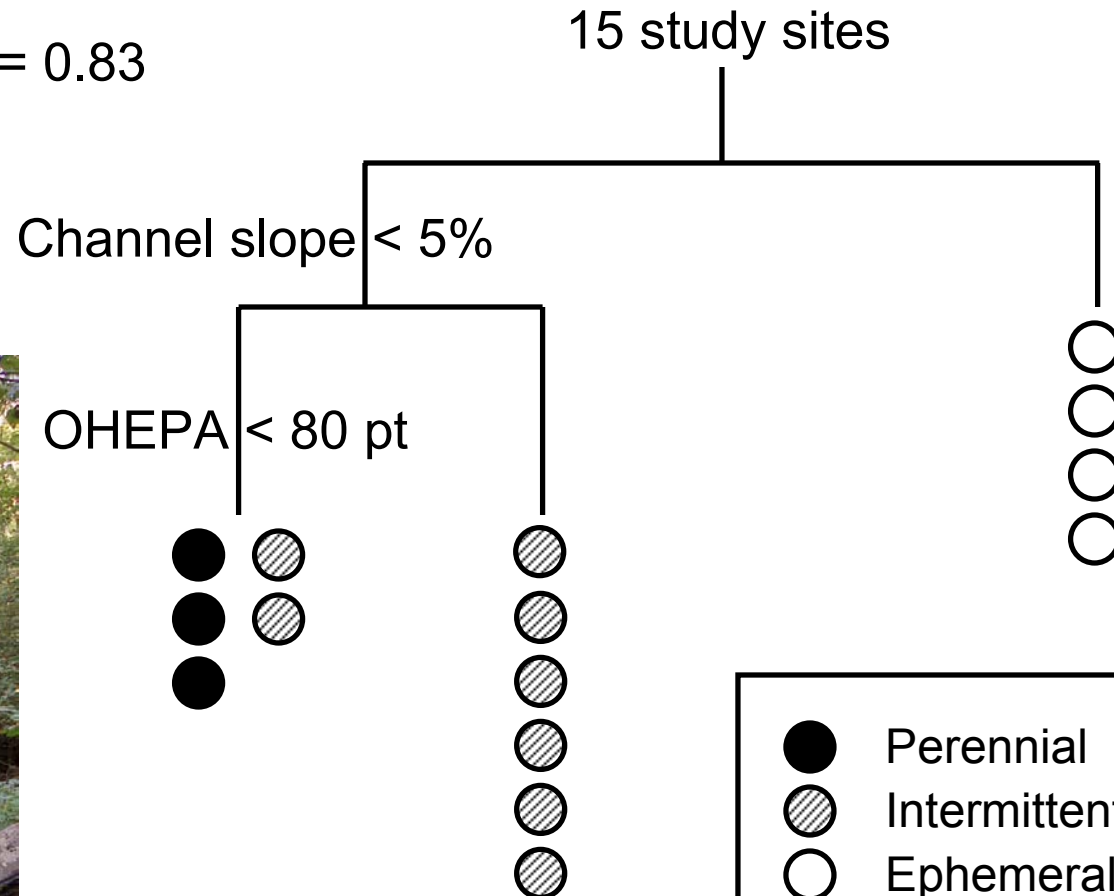
# Classification Tree Robinson Habitat

$PRE = 0.91$



# Classification Tree Hoosier Habitat

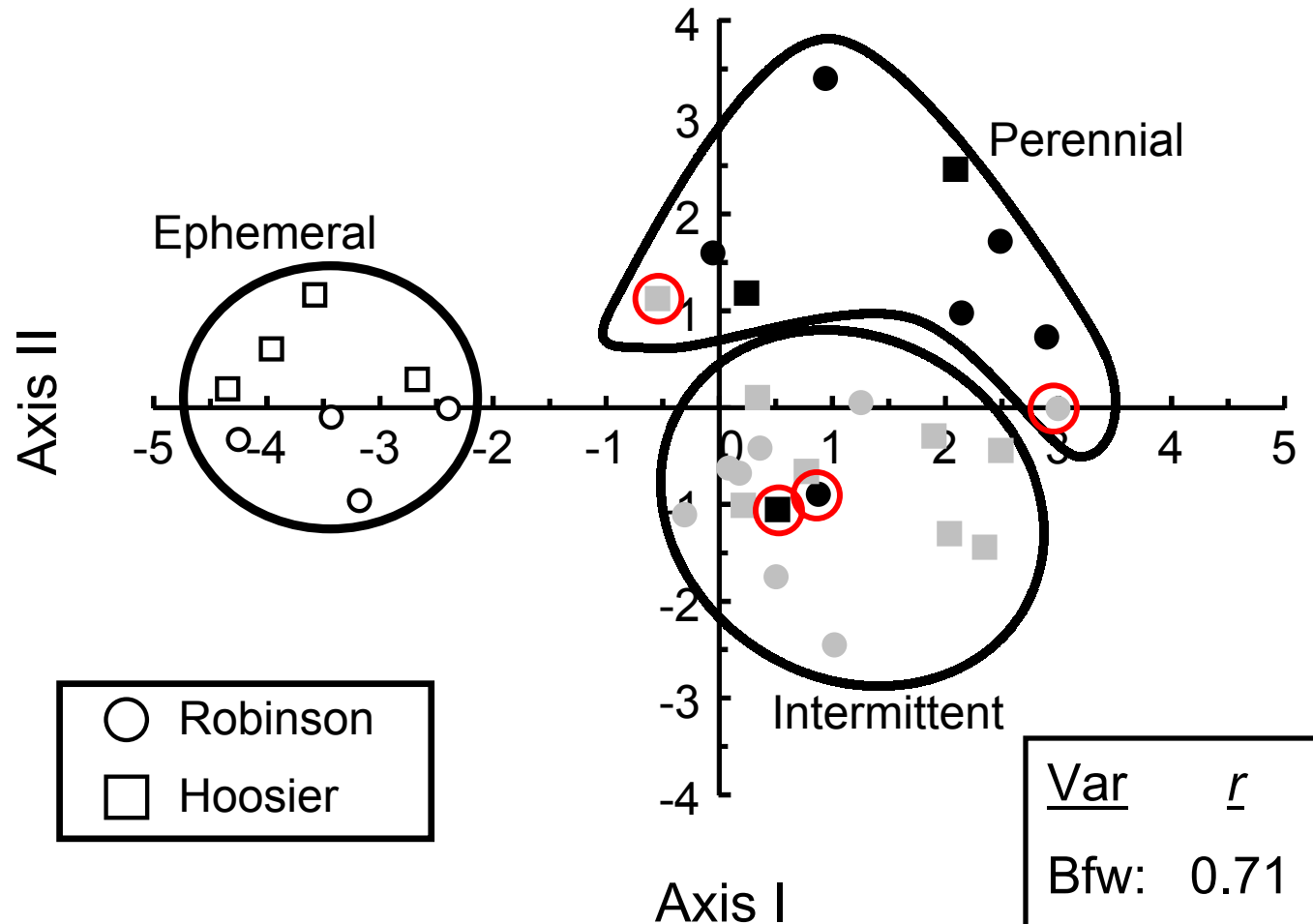
$PRE = 0.83$





# Canonical Discriminant Analysis of Physical Habitat

| Var   | $\bar{r}$ |
|-------|-----------|
| Area: | 0.66      |
| Ohio: | 0.42      |



| Var   | $\bar{r}$ |
|-------|-----------|
| Bfw:  | 0.71      |
| Area: | 0.69      |

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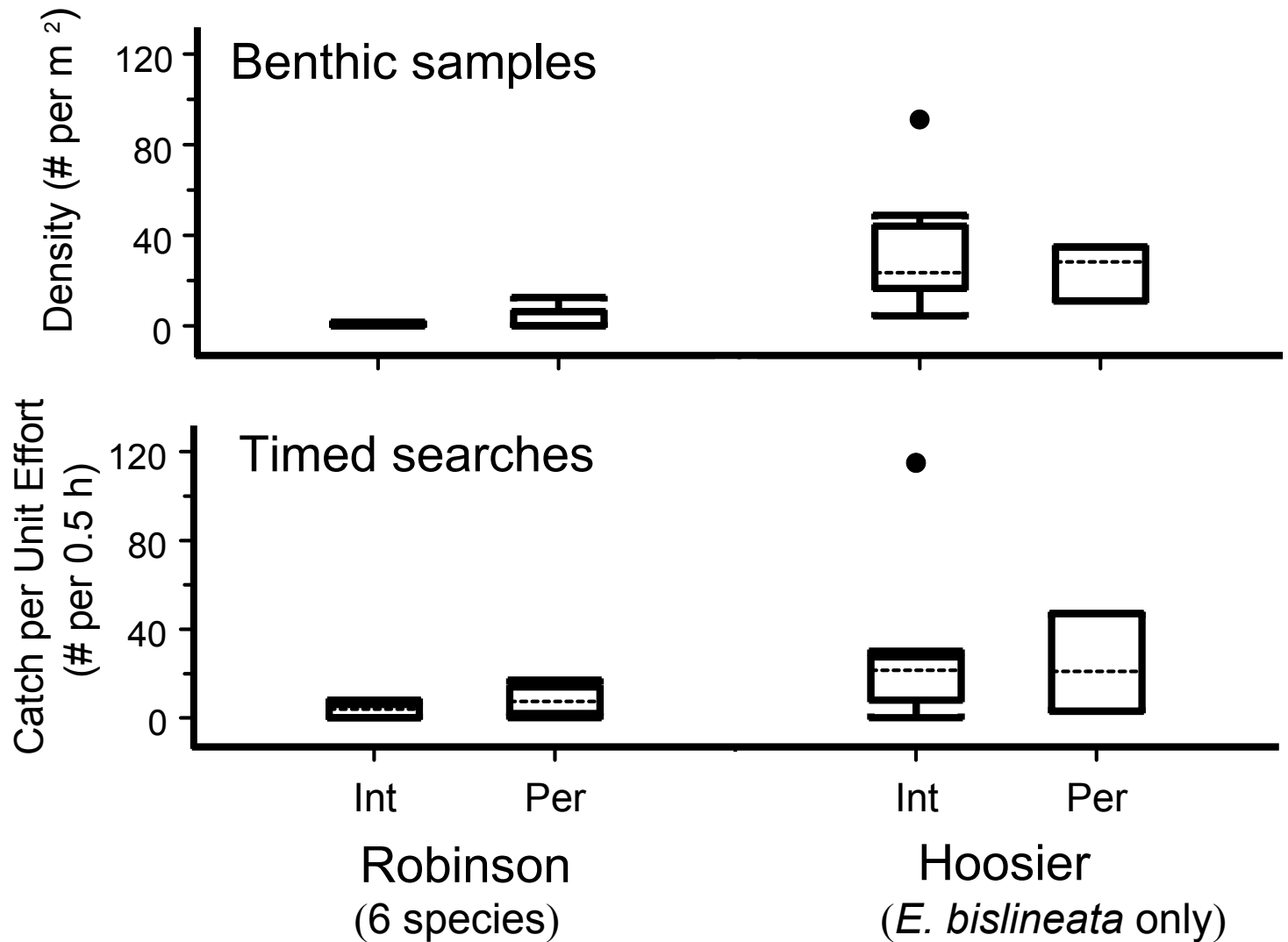
# ***Biological Data***





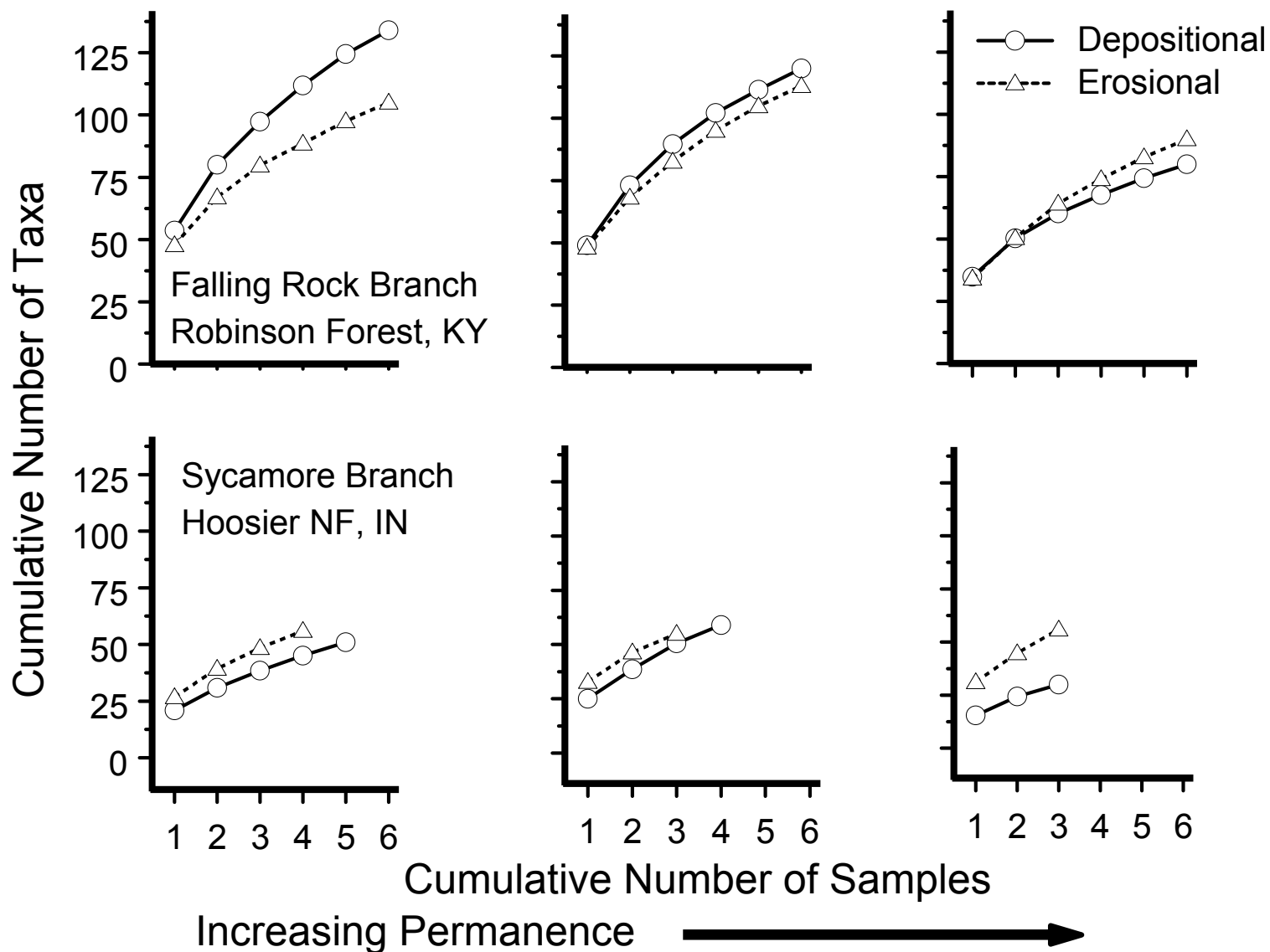
# Salamanders

## Spring 2003



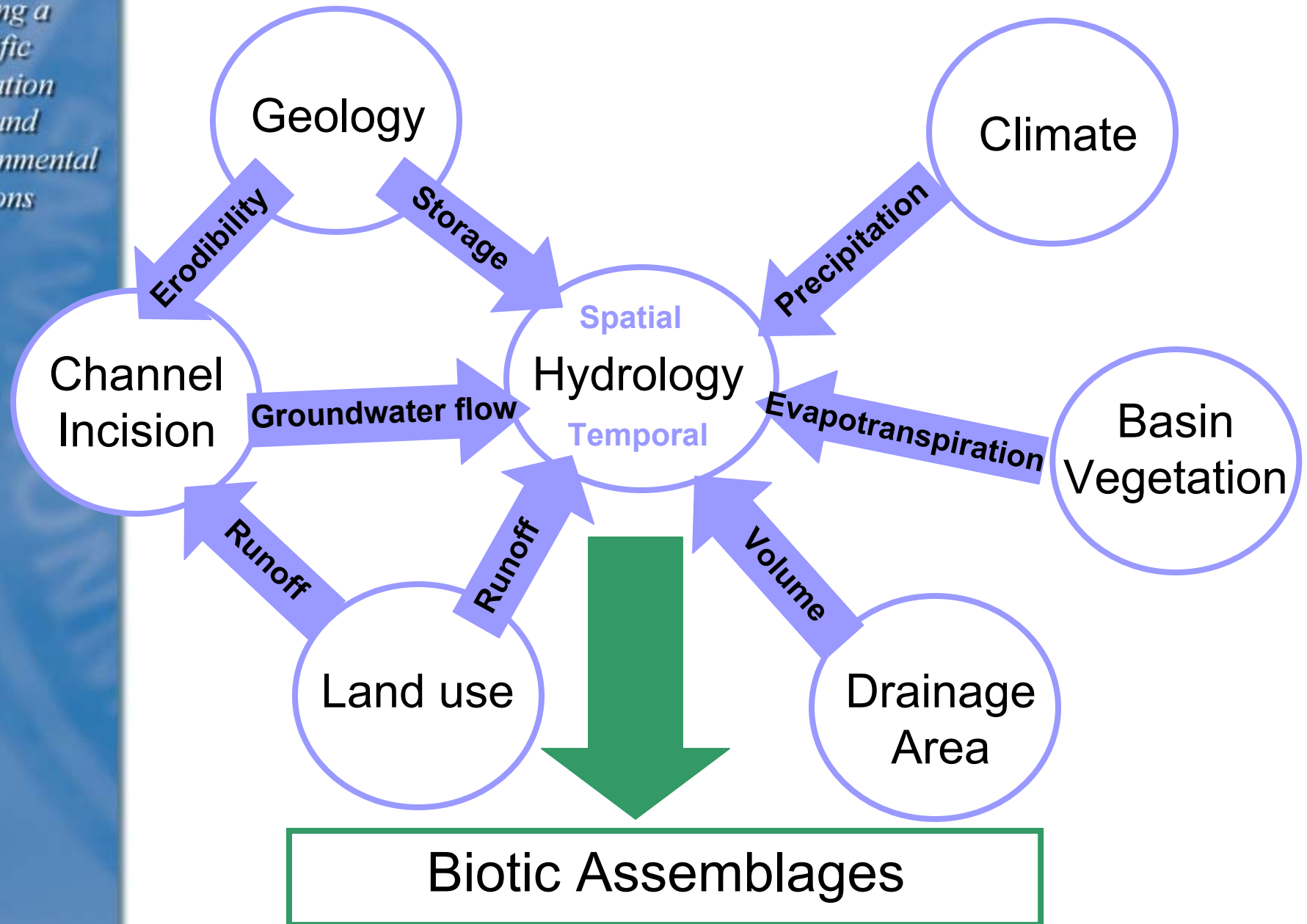


# Invertebrate Species-Area Curves





# Headwater stream hydrology



## ***Future Directions***

- 💧 Water sensors: drying frequency & duration
- 💧 Biotic indicators – *invertebrates*
  - *algae*
  - *bryophytes*
  - *amphibians*
- 💧 Role of channel incision in governing flow permanence.
- 💧 Interannual variation
- 💧 Regional variation





# Acknowledgements

- 💧 Brent Johnson, David Walters, Lori Winters, Brad Autrey, Michael Moeykens, Greg Pond (KYDW) & Jason Taylor (TNC)
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- 💧 Regions 1, 2, 3, 4, 5, 9, 10 & Technical Advisory Group
- 💧 USDA Forest Service, UK Dept. Forestry & The Nature Conservancy





